OBSERVATIONS ON AND PRELIMINARY EXPERIMENTS WITH A POLYHEDROSIS VIRUS FOR CONTROL OF CABBAGE LOOPER, *TRICHOPLUSIA NI* (HBN.)

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Because of difficulty in controlling cabbage looper, *Trichoplusia ni* (Hbn.), with insecticides in recent years, preliminary biological control trials were considered to merit investigation. DDT treatment has given only 50 to 70 per cent control in the Everglades for several seasons, and there are indications that other materials are less satisfactory than formerly. While endrin gives excellent control, its use is hampered by a zero residue tolerance, and its use is not permitted on lettuce. Although some experimental materials show promise, none are as outstanding as DDT and toxaphene were originally. The geographical magnitude of the looper control problem is indicated by the recent literature. Bibby (1957) in Arizona, Reid and Cuthbert (1957) in the southeast, and Hervey and Swenson (1956) in N. Y. discuss the difficulties in obtaining insecticidal control.

Observations in the Everglades area for several seasons have indicated that a highly infectious disease appeared to eliminate this looper completely in the late spring and early summer. Sample looper material killed by the infection was sent to Dr. S. R. Dutky of the Entomology Research Division, U.S.D.A., Beltsville, Maryland, for diagnosis. Dr. Dutky attributed the disease to a polyhedrosis virus of cabbage looper. The disease under natural conditions of the epizootic usually appears so late in the season that fullest benefit is not derived from it. Investigations of the diseases usefulness when applied to the larval environment prior to natural appearance of the virus in the field were accordingly undertaken.

The literature of Polyhedrosis disease of cabbage looper is not extensive. Chapman and Glasser (1915) listed *Autographa brassicae* Riley (*Trichoplusia ni*) as a host of a polyhedrosis virus in 1915. Sweetman (1936) also lists *Autographa brassicae* as attacked by this disease. Steinhaus (1949) states only that a polyhedrosis virus affects the species here and in Russia. Genung (1951) reported very rapid reduction of cabbage looper population in the Everglades in 1951, and Florida Experiment Station workers Hayslip *et al.* (1953), have briefly mentioned the disease as a natural control factor. Semel (1956) discussed an epizootic on Long Island in 1956. Genung (1955) and Hall (1957) have reported use of the virus in Biological Control experiments in Florida and California, respectively.

FIELD OBSERVATIONS

DESCRIPTION OF DISEASED LOOPERS: Cabbage loopers infected with this virus generally assume a yellowish or whitish, to mottled white coloration one to three days prior to death. Feeding may continue until an hour or

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two prior to the infected larva's death. After dying (Figure 1) the infected larva remains attached to the foliage by its prolegs. The cuticula becomes soft, the entire body becomes extremely flaccid and the dead insect usually hangs head downward. Discoloration and virtual liquefaction of the body contents proceeds at a very rapid rate. Observable changes occur in less than one hour. The body wall ruptures easily, often through weight of its own contents and the contents pour out upon the foliage. Freshly killed loopers are usually very pale but darken rapidly, becoming mottled with brown and eventually becoming dark brown to nearly black. Finally, only an amorphous tar-like spot remains on the foliage where the larva died.

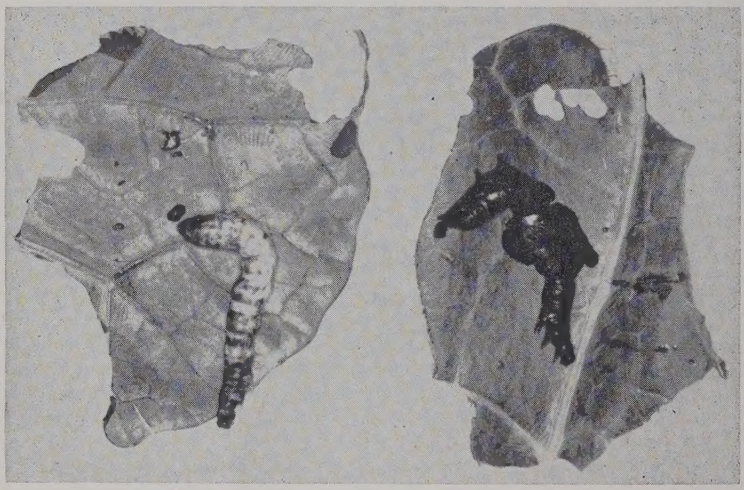

Fig. 1. Polyhedrosis killed cabbage loopers; left, one hour after death; right, eight hours after death.

OBSERVATIONS ON PROGRESS OF THE DISEASE: An infected looper brought from the field at 10:00 a.m. fed until about 11:30 a.m., died by 1:30 p.m., and turned almost brown by 5:00 p.m. Three infected larvae in the insectary that were still feeding at 5:00 p.m. had died and become dark brown by 8:00 a.m. of the following day.

The polyhedral bodies characteristic of the disease and present in the blood of infected loopers can be seen with aid of a compound microscope in blood samples from freshly killed loopers.

Infection in the pupal stage appears to occur only in the very early stage of pupation and then only when the pre-pupa was infected prior to pupation.

RAPIDITY OF CONTROL UNDER NATURAL CONDITIONS: From the first appearance of the disease in the field until virtual elimination of the looper population, under conditions of heavy looper infestation, usually requires about two to four weeks in the Everglades area. In most seasons the disease appears in late April or early May, but may occur as early as the first of April. Temperature and humidity may be important factors

in rapidity of development of the natural epizootic. Population density appears to be important in rate of development of the infection.

PROBABLE AGENTS OF DISSEMINATION: Water on the foliage is probably important in speeding the infection of loopers on individual plants. Rainwater or heavy dews will carry the virus over the leaf and will spread the infection to other leaves or plants while running off.

Dipterous insects appear to be among the most likely insect vectors of the disease to loopers on other plants or to distant plantings. Muscidae, Sarcophagidae, and Larvaeovoridae are attracted to the semi-liquified viruliferous material on which they feed in large numbers. These restless, strong-flying insects, contaminated by the virus, may thus transfer the disease to looper infested foliage at considerable distances from the source of contamination. Other insects, particularly those that would be attracted to the infectious materials, can be suspected as mechanical vectors. Ovipositing adult moths fluttering about the contaminated foliage may infect the ova at time of egg deposition. Finally, it appears that under dry conditions the virus or particles containing the virus may be airborne.

SPECIFICITY: The virus appears specific to *Trichoplusia ni* larvae. Such closely related phalaenids as *Autoplusia egena* (Gn.) and *Anomis* sp. appeared immune to the infection, as all attempts to infect these species in the laboratory were unsuccessful. Semel (1956) also mentions the specificity of the virus.

EXPERIMENTAL

MATERIALS AND METHODS: For a source of infection prior to natural appearance of the disease, virus infected loopers were collected in the field in late May, 1954. Larvae were placed in half pint jars and stored at room temperature. The dead insects liquified except for a small amount of coarser sclerotized parts. When liquification was complete about ⅛ pint of the infectious material was available.

Before beginning tests sample material was submitted to Dr. Dutky for a polyhedra count. The material was found to contain 45.6 billion polyhedra per cc., on the average, with an error of ± two per cent. According to Dr. Dutky "the small amount of error of the counts indicated a good degree of homogeneity of the sample material."

A small scale pot trial and a field experiment were planned for testing the viruliferous material. Collards were selected as the looper host crop in each case. The pot trial was conducted on plants about ten inches high, set in six-inch diameter, glazed earthenware crocks, and artificially infested to get heavy concentration of larvae on a few plants. Twenty-four small plants were potted in early April and later infested with field collected larvae of various instars, excepting the last, as it was concluded that these might be ready for pupation before the virus could affect them.

Twelve plants were treated with a polyhedra spray containing 10.5 cc. of the viruliferous material thoroughly mixed in one pint of water. The infectious material was applied with a Hudson, continuous-spray-type, hand-atomizing gun of a sort commonly used for household insecticides. Enough spray was applied to wet the foliage. Fine droplet size produced no run-off and good coverage was obtained without a spreader sticker. Tanada (1956), using a bacterium and a granulosis virus for several lepido-

terous pests, obtained increased mortality by using a B-1956 spreader sticker with the disease producing agents. Considering the high polyhedra count the amount of virus material used might seem excessive; however, it was first deemed important to learn if the disease could be induced successfully prior to its natural appearance, and because of the lateness of the looper infestation, time was of critical importance. Twelve plants received no treatments and were isolated from the treated plants by approximately 100 yards distance and with protection from intervening buildings. All plants were kept outdoors. English sparrows were observed feeding on the loopers and this required partial screening to prevent mortality from this source. Mortality counts were made at different dates as shown in Figure 2.

The remaining viruliferous material was used in the field experiment, and was computed to be 0.83 ml. per gallon of water. The spray was applied to four rows of collards, 200 feet long, down wind from four untreated check rows. Because of the wind and highly infectious nature of the virus, randomization was impracticable. The polyhedra spray was applied with an estate sprayer at about 75 gallons per acre. By the time a large enough looper population occurred in the field for testing, the disease had begun to appear naturally. Counts were made one week after application on ten plants in each row. Live and dead worms were recorded to obtain the per cent mortality.

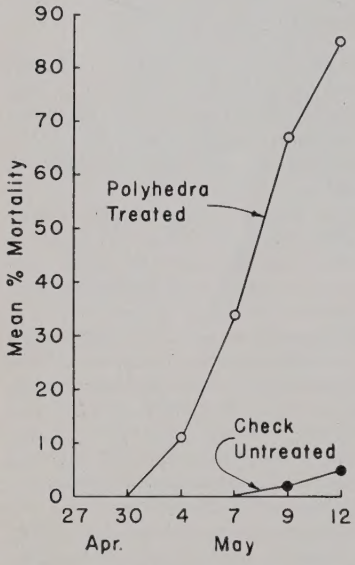

Fig. 2. Percent mortality in outdoor pot trial prior to natural appearance of the virus.

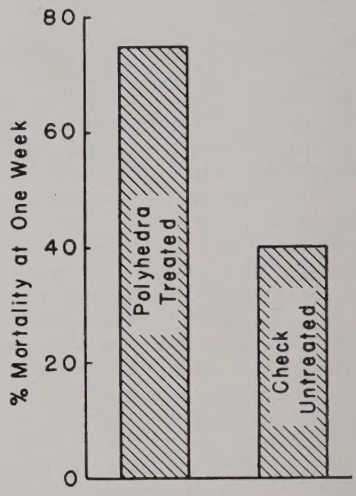

Fig. 3. Percent mortality in field obtained by applicaiton of virus after appearance of the natural epizootic, as indicated by the check.

RESULTS

As shown in Figure 2, within 15 days over 85 per cent mortality had occurred under the polyhedrosis treatment on potted plants. A five per cent mortality was recorded from the check. First mortality was observed 1 week after application when approximately 11 per cent of the larvae succumbed. The five days to first mortality, originally reported in this work (1955), is now believed to have been due to another cause since 48 hours additional time was required for occurrence of any further mortality, a total of seven days to first larvae death. Mortality reached 33 per cent three days later and 67 per cent after two more days. Mortality exceeded the 87 per cent figure shown, as all the worms were eventually killed on the treated plants. At this time only about 15 per cent of the larvae on the checks had been affected (Figure 3), but no mortality occurred in the checks until about 70 per cent kill occurred in treated plants. It is believed that infection in the checks was caused by experimental contamination, but it may have resulted from natural factors. First mortality was of young larvae, mortality of older larvae was delayed, but all eventually died of the virus.

Results of the field experiment were partially obscured by the natural epizootic. However, the percentage of dead loopers in the virus treated plots was from 20 to 50 per cent higher than in the untreated checks, indicating that had the natural occurrence of the disease been delayed considerable effectiveness could reasonably have been anticipated within two weeks of application. Due to higher temperatures both larval development and incubation period of the disease seemed more rapid than in the pot trial, although substantiating data were not obtained for this. The mean per cent of control for the field experiment is shown in Figure 3. The Polyhedra treatment was not statistically superior to the check. However, there was a consistent superiority of the polyhedra treatment and with more observations significant differences would undoubtedly have been obtained from the field trial.

SUMMARY AND CONCLUSIONS

A Polyhedrosis virus indicated a high degree of effectiveness for control of cabbage looper, *Trichoplusia ni* (Hbn.), in an outdoor pot trial during late April and early May, using a very heavy concentration of Polyhedra. The disease showed first mortality 7 days after application and gave nearly complete control of loopers within three weeks.

Effectiveness of the virus during late May in a small field test was partially obscured by the natural appearance of the disease. However, results were sufficiently clear cut that further investigations appear desirable, as this phalanid has become increasingly difficult to control with insecticides.

Grower interest in Polyhedrosis virus for looper control would probably be slow to develop for the following reasons: (1) Several days would be required from time of application for visible results. (2) Maintaining a source of inoculum would require special efforts to produce, harvest, and store the material.

Use possibilities that need exploration are: (1) Application of the virus as a control of serious outbreaks when insecticides fail or (2) Inclusion of the inoculum regularly with an insecticide as a supplementary control measure. However, the preliminary tests reported here offer only indications and do not give sufficient evidence at this time either to limit or to suggest use of this polyhedrosis virus beyond the realm of experimentation.

ACKNOWLEDGMENTS

Mr. C. E. Seiler, field assistant, assisted in various phases of the work. Messrs. H. M. Spelman III and Edward King did the photographic work and prepared the graphs, respectively.

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EFFECT OF TEMPERATURE, AERATION, pH, AND THE PRESENCE OF SOIL ON THE TOXICITY OF VARIOUS INSECTICIDES TO MOSQUITO LARVAE

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The use of water-soluble insecticides for the control of floodwater *Aedes* mosquitoes by introducing the chemical into irrigation water as it flows into the fields has been studied for several years. Following laboratory studies in Orlando, Florida (Gahan *et al.*, 1955a, 1955b), field studies in California (Gahan and Mulhern, 1955c) and in Arkansas (Gahan and Noe, 1955d) showed it to be a promising method. Further studies in 1956 (unpublished) indicated that the effectiveness of this method decreased over long distances of flow and in shallow water. Laboratory studies were therefore made to determine factors responsible for this loss of effectiveness in order to aid in finding a chemical or developing a formulation that would increase the efficacy of this type of treatment. Fourth-instar larvae of *Anopheles quadrimaculatus* Say were the test insects.

EFFECT OF TEMPERATURE, AERATION, AND pH

Distilled water treated with four organophosphorus insecticides at approximately twice the LC-100—parathion 0.02, malathion 0.5, Diazinon 0.05, and Dipterex 0.5 p.p.m.—was aged for 24 hours under various conditions of temperature, aeration, and pH. To determine the effect of temperature, the treated water was placed in an oven heated to 110°, 120°, or 130° F. For aeration studies, air from a small aquarium pump was bubbled through the treated water. In tests on the effect of pH, sodium bicarbonate was added to the distilled water to give a pH of 8.0 or 9.0. Controls for all test conditions consisted of treated water aged for 24 hours at 80° F. The water was treated by pipetting an acetone solution of the insecticide into it to give the desired concentration. After the aging period, four dilutions were prepared and tested in duplicate jars against mosquito larvae. From the mortality after 24 hours the LC-50's were determined for each aging condition. Loss of toxicity was indicated by an increase in the LC-50 over that of the controls. Results are given in Table 1.

Aging for 24 hours at pH 8.0 and 9.0 did not greatly reduce the toxicity of any of the materials. A slight loss of toxicity was apparent at both

TABLE 1. LC-50's (PARTS PER MILLION) OF ACETONE-WATER PREPARATIONS OF FOUR INSECTICIDES AGED FOR 24 HOURS UNDER DIFFERENT CONDITIONS OF TEMPERATURE, AERATION, AND pH.

		Temperature (° F.)				pH	
Insecticide	Control	130	120	110	Aeration	8.0	9.0
Parathion	0.0046	>0.01	0.0054	0.0054	0.0041	0.0044	0.0038
Malathion	.058	—	.16	.058	.074	.060	.076
Diazinon	.027	—	.049	.050	>.050	.030	.030
Dipterex	.14	.35	.15	—	.13	.11	.10

pH's with malathion but not with Dipterex and parathion. Aeration greatly decreased the toxicity of Diazinon and slightly decreased that of malathion, but did not affect parathion or Dipterex. When these materials were heated, the toxicity of Dipterex was reduced at 130° but not at 120°, parathion at 130° but only slightly at 120° and 110°, malathion at 120° but not at 110°, and Diazinon at both 120° and 110° F. Parathion and Dipterex were the most stable to the factors tested and Diazinon was the most susceptible.

EFFECT OF PRESENCE OF SOIL

Since temperature, aeration, and pH did not seem to account for the loss in toxicity observed in the field, the effect of the presence of soil was tested.

In the first experiment water treated with parathion at 0.02 p.p.m. from an acetone solution or a mixture of 1 part of parathion plus 4 parts of Triton X-100 was placed over 50 grams of builders' sand or soil in glass jars 3 inches in diameter and allowed to stand for 24 hours. The soil was Florida soil consisting of a sandy base with a large amount of organic matter. Three volumes of treated water (50, 100, and 150 ml.) were used. In one series the treated water was poured rapidly over the soil or sand to cause agitation, and in another it was poured slowly over the sand or soil, which was covered with a filter paper, to prevent agitation. After the aging period 25 larvae in 25 ml. of distilled water were placed in each test jar and the mortality was read after an additional 24 hours. Several checks and controls were run to ensure the accuracy of the tests. In the checks untreated water, alone or in the presence of sand or soil without insecticide, caused no mortality. In the controls the presence of filter paper alone did not appreciably decrease the toxicity of the insecticide, and 50 ml. of water treated with both formulations of the insecticide with no sand or soil present killed all larvae in 24 hours.

The concentration of parathion initially prepared was approximately twice the LC-100. Addition of test larvae in 25 ml. of water further diluted the material so that the final test concentration was different for each volume. However, it was still greater than the LC-100. Therefore, some loss of toxicity could have occurred even though complete kill was obtained. These tests were designed to find large losses in effectiveness, and the following discussion refers only to loss evident from these tests. The results are given in Table 2.

Water treated with either formulation lost little toxicity in the presence of sand, but in the presence of soil there was a large loss. In jars in which the soil was agitated the loss was greater than in those in which filter paper prevented agitation. However, even in the test with non-agitated soil the mortality was low, indicating that toxicity was lost by contact with the soil through the filter paper. The lower mortality in the smaller volumes of treated water indicated that the loss was greater in shallower water. Mortality was lower with the Triton X-100 formulation than with the acetone solution. Apparently the Triton X-100 increased the adsorption of parathion. In this experiment it was impossible to show whether the loss of toxicity resulted from adsorption or breakdown of parathion; however, the former appears to be the more probable cause.

TABLE 2. PERCENT MORTALITY OF MOSQUITO LARVAE IN WATER TREATED WITH TWO PARATHION FORMULATIONS AND AGED FOR 24 HOURS OVER SOIL OR SAND, WITH AND WITHOUT AGITATION.

Milliliters of Treated Water	Over Soil		Over Sand	
	Triton X-100	Acetone	Triton X-100	Acetone
		Agitated		
50	0	2	96	100
100	16	36	100	100
150	68	82	100	100
		Not agitated		
50	22	74	90	100
100	84	100	100	100
150	94	100	100	100

A second experiment was run to determine whether the same loss of toxicity would occur with a heavy clay soil from a California test plot. The experiment was run in the same manner, except that acetone solutions of four insecticides were used and the soil in all jars was covered with filter paper. Parathion was used at 0.02, Dipterex at 0.5, malathion at 0.3, and Phosdrin at 1 p.p.m. As shown in Table 3, all four insecticides lost toxicity when tested over this soil sample at the two smaller volumes.

TABLE 3. PERCENT MORTALITY OF MOSQUITO LARVAE IN WATER TREATED WITH FOUR INSECTICIDES AND AGED FOR 24 HOURS OVER SOIL FROM CALIFORNIA. (4 REPLICATIONS.)*

Milliliters of Water Over Soil	Parathion	Dipterex	Malathion	Phosdrin
50	1	0	0	0
100	72	49	66	93
150	100	97	88	100

* 50 ml. of treated water with no soil used as controls gave 100% mortality with all four materials.

Finally, 18 insecticides were tested to determine their relative loss of toxicity over Florida soil. Water treated with acetone solutions of the insecticides was poured over soil protected by filter paper and aged 24 hours. Control lots were aged 24 hours without soil. Most of the concentrations used were twice the LC-100; but this information was not available for some insecticides and the concentrations used proved to be less than the LC-100. Table 4 gives the results of these tests. Two materials, 2,4-dimethylbenzyl chrysanthemumate and 2,4-dimethylbenzyl 2,2-dimethyl-3-(2-methylpropyl)cyclopropanecarboxylate, showed no loss of toxicity.

TABLE 4. EFFECT OF AGING FOR 24 HOURS IN THE PRESENCE OF SOIL ON THE TOXICITY OF INSECTICIDES ADDED TO WATER AS ACETONE SOLUTIONS.

Insecticide	Concentration (p.p.m.)	Percent Mortality			
		No Soil	50 Grams of Soil		
		50 ml.	50 ml.	100 ml.	150 ml.
Barthrin	0.2	100	78	100	100
1-Naphthyl methylcarbamate (Sevin)	1.0	100	0	4	52
6-Bromopiperonyl chrysanthemumate	.2	84	46	96	98
2-Chloroethyl 2,2-dichlorovinyl methyl phosphate	2.0	100	0	100	100
1-Chloromethylethyl 2,2-dichlorovinyl ethyl phosphate	1.5	100	80	100	100
2,4-Dimethylbenzyl chrysanthemumate	.1	98	96	100	100
Piperonyl chrysanthemumate	1.0	100	30	98	100
2,4-Dimethylbenzyl 2,2-dimethyl-3-(2-methylpropyl)-cyclopropanecarboxylate	.1	50	58	98	100
DDVP	.2	100	2	12	20
Diazinon	.1	100	54	100	100
Dicapthon	.05	100	0	2	18
O,O-Diethyl *O*-*p*-methylsulfoxide-phenylthionophosphate	.05	88	0	2	80
Dipterex	.5	100	10	44	48
EPN	.02	100	0	0	80
Ethyl DDVP	.2	100	6	20	100
Malathion	.3	100	90	98	98
Para-oxon	.01	100	6	56	98
Phosdrin	1.0	100	2	68	100
2-Chlorovinyl dipropyl phosphate	2.0	100	0	92	100
Pyrethrins	1.0	100	18	100	100

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RELATIVE SUSCEPTIBILITY OF SALT-MARSH MOSQUITOES FROM GEORGIA AND FLORIDA TO INSECTICIDES

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Laboratory tests demonstrating insecticide resistance in salt-marsh mosquitoes, *Aedes taeniorhynchus* (Wied.) and *A. sollicitans* (Wlkr.), were first reported by Deonier and Gilbert (1950), who found that larvae collected from the intensively treated area near Cocoa Beach, Florida, were more resistant to DDT than larvae from untreated areas near Titusville, Florida. Later Keller and McDuffie (1952) found that larvae from the Cocoa Beach area had developed resistance to BHC and that the resistance to DDT had increased considerably. Keller and Chapman (1953) reported resistance in the Cocoa Beach area to dieldrin as well as DDT and BHC.

Although considerable data had been collected on the susceptibility of salt-marsh mosquitoes from Florida, no laboratory tests had been conducted to compare these mosquitoes with others from an area far enough from abatement districts to minimize the possibility of migration. In the course of a search for such an area, it was learned from H. E. Schoof of the U. S. Public Health Service that the use of DDT near Savannah, Ga., prior to June 1957, had been limited to sporadic treatments with DDT as a fog. Salt-marsh mosquitoes from this area were therefore compared with those from St. Johns, Brevard, Indian River, and Broward Counties in Florida, where chlorinated hydrocarbon insecticides had been used as larvicides and adulticides for 11 years.

TEST INSECTS

Mosquito eggs were collected from Georgia and eggs or larvae from Florida. Salt-marsh sod suspected of containing eggs was inundated in the field. If viable eggs were present, larvae could be observed in the water after a short time. Sods with high concentrations of eggs were cut and transported to the laboratory where they were inundated and the hatching larvae were reared to the proper stage for testing. Larvae were also collected in the field and, if not in the proper stage when collected, were reared to testing stage in the laboratory.

LARVICIDE TESTS

Batches of 25 fourth-instar larvae of mixed populations of *A. taeniorhynchus* and *sollicitans* were exposed in 250 ml. of an acetone-distilled water suspension or solution of the insecticide according to the standard Orlando test method (Weidhaas and Gahan, 1958). DDT, BHC, dieldrin, malathion, parathion, Bayer 21/199, Diazinon, and Dipterex were tested at concentrations ranging from 0.25 to 0.0005 p.p.m. After 48 hours of exposure at 78° F., mortality counts were taken and the LC-90's calculated. Each LC-90 was based on the average mortality obtained in duplicate jars at each of three to five concentrations. In 1956 or 1957 all materials were

tested once or twice against larvae from each of four counties in Florida. Each material was tested three times against Georgia larvae during July 1957.

As shown in Table 1, the Georgia larvae were 8 to 10 times more susceptible to DDT, BHC, and dieldrin than the larvae from Florida, but there was no more than a 2-fold difference in susceptibility to the five organophosphorus insecticides.

TABLE 1. COMPUTED LC-90'S (IN P.P.M.) OF EIGHT INSECTICIDES TO SALT-MARSH MOSQUITO LARVAE FROM GEORGIA AND FLORIDA.

Insecticide	Georgia Larvae	Florida Larvae
DDT	0.008	0.088
BHC	.030	.245
Dieldrin	.012	.096
Malathion	.039	.030
Parathion	.002	.004
Bayer 21/199	.004	.007
Diazinon	.025	.048
Dipterex	.140	.117

ADULTICIDE TESTS

During 1957 salt-marsh mosquitoes from Georgia and Florida were reared to adults in the laboratory for tests with contact sprays. Groups of 100 to 200 pupae were placed in pint jars, and a 10-ounce, conical, waxed, paper cup, with 1 inch of the tip removed, was placed over the mouth of each jar to funnel the emerging adults into a cylindrical screen cage. Within 72 hours after emergence the adults were anesthetized with carbon dioxide and distributed into exposure cages made of cylindrical metal sleeves covered on each end with screen wire. Both males and females were used, and each exposure cage received 25 to 30 mosquitoes. The mosquitoes were allowed to recover fully from the anesthesia before being tested.

Solutions of DDT, BHC, and malathion, at concentrations ranging from 2.0 to 0.005% in odorless kerosene, were applied to the mosquitoes in a wind tunnel. This apparatus consisted essentially of a cylindrical tube 4 inches in diameter through which a column of air was moved at 4 m.p.h. by a suction fan. The mosquitoes contained in the exposure cage were placed in the center of the tube. One-fourth milliliter of insecticide solution was atomized at a pressure of 1 p.s.i. into the mouth of the tunnel, and the mosquitoes were exposed momentarily as it was drawn through the cage. Duplicate cages were exposed to each concentration in each test. After treatment the mosquitoes were again anesthetized, transferred to untreated screen holding cages, and held in a room with a temperature of 84° F. and a relative humidity of about 70%. A cotton pad saturated with honey-water (1:5) solution was placed on the top of each cage. The mortality was recorded after 24 hours. Ninety-three percent of the 5,830 mosquitoes from Florida and more than 99% of the 1,902 from Georgia

were *taeniorhynchus*. Two tests were made with each material against the Georgia mosquitoes and from five to nine against those from Florida. The LC-90's computed from these tests are shown in Table 2.

TABLE 2. COMPUTED LC-90'S (IN PERCENT) OF THREE INSECTICIDES AS CONTACT SPRAYS AGAINST ADULT SALT-MARSH MOSQUITOES FROM GEORGIA AND FLORIDA.

Insecticide	Georgia Adults	Florida Adults
DDT	0.120	0.940
BHC	.120	.150
Malathion	.098	.041

The adults from Georgia were 7.8 times more susceptible to DDT than those from Florida, but there was little difference in susceptibility to BHC. Adults from Florida were 2.4 times more susceptible to malathion than adults from Georgia.

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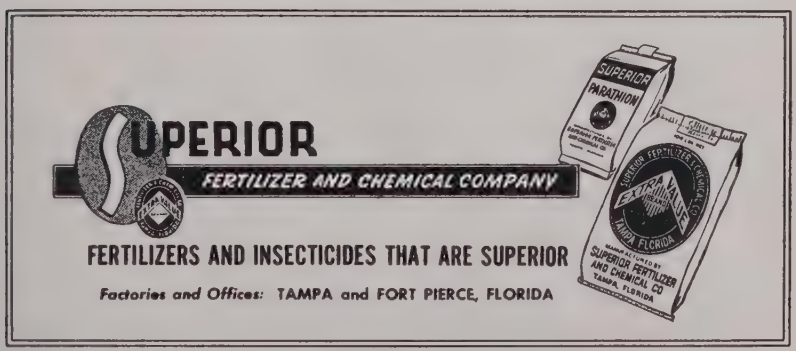

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SEVEN NEW *TYPHLODROMUS* FROM MEXICO WITH COLLECTION NOTES ON THREE OTHER SPECIES (ACARINA: PHYTOSEIIDAE)

Donald De Leon
Erwin, Tennessee

The species treated below belong to the group of typhlodromids with four pairs of anterior lateral setae. Chant (1957a) placed this group in *Amblyseius* Berlese which he considered a subgenus of *Typhlodromus* Scheuten. He discussed the reasons for this action in a later paper (Chant, 1957b). As he also shows in his study of the immature stages of some phytoseiids (Chant, 1958), the typhlodromids with the above character appear, on the basis of setal development, to be more closely related to the species in the genera *Amblyseius* Berlese and *Amblysciopsis* Garman than they do to the typhlodromids with more than four pairs of anterior lateral setae. But the placing of typhlodromids with four pairs of anterior lateral setae with the amblyseiids brings together mites of very different facies. To distinguish this group from the amblyseiids it is proposed that it be removed from *Amblyseius* Berlese and be given subgeneric rank, the subgenus being named and characterized as follows:

> *Typhlodromopsis*, n. subgen. Phytoseiids resembling *Typhlodromus sensu stricto* in general facies, but with four pairs of anterior lateral setae; the lateral setae all more or less of the same lengths, none of them (or M2) long and whip-like; M2 and ultimate lateral seta usually strongly pectinate; dorsal setae 2 to 5, especially D4 and D5, about as long as or at least not very much shorter than most of the laterals. Ventrianal shield with not more than three pairs of preanal setae. Legs without long, whip-like setae. Typical species of subgenus: *Typhlodromus cucumeris* Oudemans.

In the following descriptions all measurements are in microns and are averages unless variations from average is more than ten per cent, in that case the range is given. In the use of metapodal shield and metatarsus for what, in previous papers, I called the parapodal shield and the basitarsus, I have followed Evans (1957). I have used the names proposed by Garman (1948) for the setae of the dorsal shield.

Typhlodromus (Typhlodromopsis) finlandicus (Oud.) (1915)

T. finlandicus is common and widely distributed in Mexico. It was collected on 26 occasions and from about as many different plants. Representative collections are listed below:

Mante, S.L.P., December, from *Sabal palmetto*.
Veracruz, Ver., December and January, from *Achras zapota*, coconut, and others.
Tuxtla Gutierrez, Chiapas, January, from avocado, mahogany, and others.
San Cristobal de las Casas, Chiapas, January, from peach.
Guadalajara, Jal., March, from pomegranate, *Bougainvillea*, and ash.
Puerta Vallarta, Jal., May, from *Bursera* sp.

Tepic, Nay., March, from *Verbesina* sp. and others.
San Blas, Nay., March, from an unknown host.

Typhlodromus (Typhlodromopsis) mesembrinus Dean (1957)

T. mesembrinus was collected chiefly in the area around Tuxtla Gutierrez, Ch. in January from a large variety of plants including mango, avocado, *Annona* sp., and *Diospyros ebenaster*. It was also taken from pear in December near Montemorelos, N. L., from coffee at Tamazunchale, S.L.P., and from *Malvaviscus* sp. in January at Veracruz.

Typhlodromus (Typhlodromopsis) peregrinus Muma (1955)

T. peregrinus appears to be limited to the east coast of Mexico and to the section round Tuxtla Gutierrez, Ch. A list of representative collections follows:

Tamazunchale, S.L.P., December, from *Asclepias curasavica*.
Veracruz, Ver., December and January, from *Sclerocarpus* sp., *Cupania macrophylla, Gliricidia sepium,* and a half dozen other plants.
Cordoba, Ver., February, from *Bursera simaruba* and *Erythrina* sp.
Jalapa, Ver., March, from *Inga* sp.
Coatzcoalcos, Ver., January, from *Waltheria brevipes* and *Rhyncanthera mexicana*.
Tuxtla Gutierrez, Ch., January, from *Achras zapota, Tecoma stans,* and six other species of plants.

The specimens of *T. peregrinus* collected in Mexico have for the most part longer setae on the dorsal shield than do the Florida specimens, the laterals especially being noticeably longer. The Mexican specimens were first thought to be distinct, but the spermatophore bearer of the male is so similar to that of the male *peregrinus* from Florida it is unlikely they are separate species.

Figures 1- 3. *Typhlodromus (Typhlodromopsis) planetarius*, n. sp. ♀, dorsal shield, metapodal shields, and ventrianal shield.

Figures 4- 6. *Typhlodromus (Typhlodromopsis) quercicolus*, n. sp. ♀, dorsal shield, metapodal shields, and ventrianal shield.

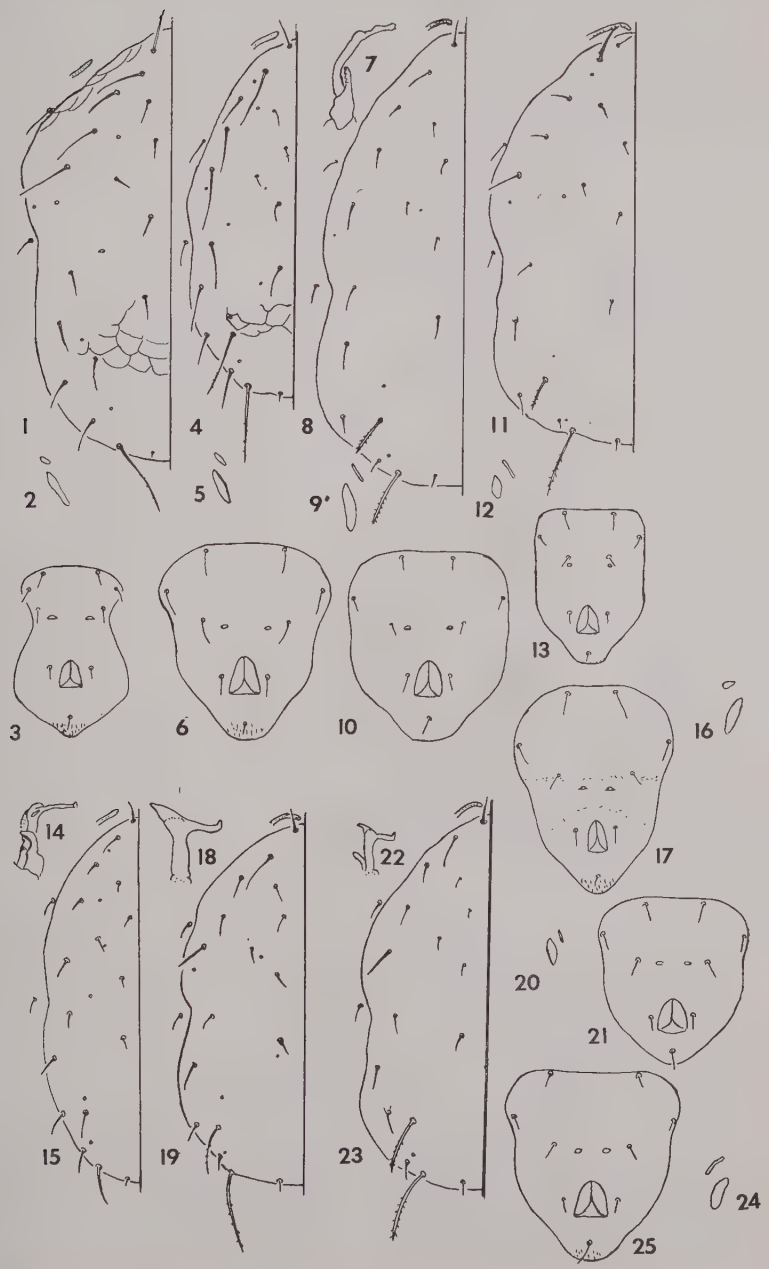
Figures 7-10. *Typhlodromus (Typhlodromopsis) fordycei*, n. sp. ♂, spermatophore; ♀, dorsal shield, metapodal shields, and ventrianal shield.

Figures 11-13. *Typhlodromus (Typhlodromopsis) simplicissimus*, n. sp. ♀, dorsal shield, metapodal shields, and ventrianal shield.

Figures 14-17. *Typhlodromus (Typhlodromopsis) cucumeroides*, n. sp. ♂, spermatophore; ♀, dorsal shield, metapodal shields, and ventrianal shield.

Figures 18-21. *Typholodromus (Typhlodromopsis) sabali*, n. sp. ♂, spermatophore; ♀, dorsal shield, metapodal shields, and ventrianal shield.

Figures 22-25. *Typhlodromus (Typhlodromopsis) confertus*, n. sp. ♂, spermatophore; ♀, dorsal shield, metapodal shields, and ventrianal shield.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Typhlodromus (Typhlodromopsis) planetarius, n. sp.
(Figures 1-3)

T. planetarius appears to be most closely related to *T. peregrinus* Muma but differs from that species by having much larger lateral setae, L1 to L4 being about as long as or longer than the distances between their bases and L7 and L8 being about equal in length and longer than M2.

FEMALE: Dorsal shield 282 long, 182 wide, rather coarsely imbricate, and with 17 pairs of setae of the following lengths: L1 29, L2 27, L3 32, L4 37, L5 19, L6 26, L7 25, L8 29, L9 49-56 (sparsely and minutely pectinate); M1 20, M2 22; D1 28, D2 20, D3 18, D4 18, D5 20, D6 9; VL1 31; S1 31, S2 18. Peritreme extending forward about to anterior margin of coxa II. Sternal shield indistinct; genital shield 74-85 wide; ventrianal shield 90 long, 49-58 wide (at anterior widening) with three pairs of preanal setae and a pair of half-round pores and bordered by four pairs of interscutal setae including VL1; two pairs of metapodal shields. Digits of chelicerae apparently without teeth (but digits poorly oriented). Leg IV with macrosetae of the following lengths: genu 23, tibia 20, metatarsus 38; other legs without macrosetae.

MALE: Not known.

Holotype: Female, Tepic, Nay., March 25, 1957 (D. De Leon), from *Inga spuria*. *Paratypes:* One female, same data as for holotype; two females, Santa Maria del Oro, Nay., March 24, from *Clethra* sp.

Typhlodromus (Typhlodromopsis) quercicolus, n. sp.
(Figures 4-6)

T. quercicolus resembles *T. masseei* Nesbitt 1951 as described by him, but differs from it most noticeably by its smaller size, by L5 being nearly as long as L6, and by D4 and D5 being appreciably longer than D2 and D3.

FEMALE: Dorsal shield nearly smooth, except at anterolateral margins and area between D5 and M2 where it is weakly and coarsely imbricate, 355 long, 210 wide with 17 pairs of setae of the following lengths: L1 45-54, L2 29-35, L3 37-47, L4 47-63, L5 42-62, L6 47-54, L7 42-49, L8 36-45, L9 72-83; M1 7-13, M2 63; D1 22-29, D2 14-18, D3 11-15, D4 20-28, D5 27-38, D6 10. M2 and L9 minutely and sparsely pectinate. Sternal shield with three pairs of setae; genital shield 74-88 wide; ventrianal shield 115 long, 96 wide with three pairs of preanal setae and a pair of pores and bordered by four pairs of interscutal setae including VL1 which is 59 long; two pairs of metapodal shields, the primary one 27 long and 7 wide; fixed digit with a sub-terminal tooth and with five small teeth in the middle third and the *pilus dentilis;* movable digit not observable. Legs with setae rather long and slender with macrosetae not much longer than the others, a macroseta on genua I-IV and on tibia IV and metatarsus IV; macrosetae of leg IV of the following lengths: genu 42, tibia 35, metatarsus 68.

MALE: Not known.

Holotype: Female, Quiroga, Mich., March 11, 1957 (D. De Leon), from *Quercus* sp. *Paratypes:* One female, Chuparcuero, Mich., other data as for holotype, and one female, Ciudad del Maiz, S.L.P., June 11, 1957, from *Quercus* sp.

Typhlodromus (Typhlodromopsis) fordycei, n. sp.
(Figures 7-10)

T. fordycei resembles *T. reticulatus* Oudemans, but differs from Chant's redescription of that species (Chant, 1958) by the ventrianal shield having a pair of pores, by the male having 3 pairs of preanal setae, and in other characters.

FEMALE: Dorsal shield 324 long, 188 wide with 17 pairs of setae. All laterals, except L9, 18-27 long, L6 the longest; L9 67 long; M2 36 long; all dorsals, except D6, 14-21 long, D1 and D5 of about the same lengths. Sternal shield with three pairs of setae; genital shield 72 wide; ventrianal shield 110 long, 95 wide with three pairs of preanals and a pair of pores; four pairs of interscutal setae including VL1 bordering the ventrianal shield; two pairs of metapodal shields, the primary pair about 27 long. Fixed digit with apparently five teeth along middle third, teeth of movable digit not observable. Genua I-IV with macrosetae 21, 15, 25, and 33 long respectively, tibia and metatarsus IV each with a macroseta 19 and 39 long respectively; all macrosetae rather large and expanded at tips.

MALE: Resembles female; dorsal shield 267 long, 166 wide. Ventrianal shield with three pairs of preanal setae and a pair of pores. Spermatophore bearer more or less evenly curved, about 31 long measured in a straight line from base to tip.

Holotype: Female, La Tinaja, Ver., February 5, 1957 (D. De Leon), from *Pithecolobium lanceolatum*. *Paratypes:* Four females, two males, other data as for holotype; one male, Cordoba, Ver., February 5, 1957, from banana.

The mite is named in honor of Mr. J. B. Fordyce of Apple Valley, Calif.

Typhlodromus (Typhlodromopsis) simplicissimus, n. sp.
(Figures 11-13)

T. simplicissimus differs from other mites with nine rather short lateral setae and L7 paired with M2 chiefly in having L2 and L3 distinctly shorter than L1 or L4, by the ventrianal shield having pores almost directly behind and close to the bases of the posterior pair of preanals, and by the numerous small teeth on the fixed digit.

FEMALE: Dorsal shield 317 long, 208 wide with nine lateral, two median, and six dorsal pairs of setae; the lengths of most of these setae follow: L1 30, L2 11-20, L3 18, L4 25-36, L5 17, L6 18-23, L7 14-18, L8 10, L9 56-72; M1 11, M2 28-44; D1 21, D3 11, D5 17. Sternal shield with three pairs of setae; genital shield 77 wide; ventrianal shield 105 long, 74 wide with three pairs of preanal setae and a pair of pores almost directly behind and close to the bases of the posterior pair of preanals; ventrianal shield bordered by four pairs of interscutal setae including VL1 which is 38 long; two pairs of metapodal shields the primary one 18 long and about 6 wide, the accessory 17 long and about 3 wide. Fixed digit with about 12 very small teeth on the basal two-thirds and three somewhat larger, more rounded, sub-apical teeth; movable digit with three teeth. Genua I-IV each with a macroseta 24, 23, 25, and 35-44 long respectively; tibia and metatarsus IV each with a macroseta 18 and 35-44 long respectively, all macrosetae tapering to a fine point.

MALE: Not known.

Holotype: Female, Cordoba, Ver., February 4, 1957 (D. De Leon), from *Eugenia jambos.* *Paratypes:* One female, Veracruz, Ver., January 1, 1957, from *Cupania macrophylla;* two females, Cordoba, Ver., February 4, 1957, one from *Bursera simaruba* and one from *Miconia glaberrima.*

Typhlodromus (Typhlodromopsis) cucumeroides, n. sp.
(Figures 14-17)

T. cucumeroides resembles *T. cucumeris* Cudemans, but differs from the description of that species in Nesbitt (*l.c.*) by its greater size, by the shape of the ventrianal shield, by lacking a macroseta on metatarsus IV, and by other characters.

FEMALE: Dorsal shield rather coarsely and strongly imbricate, 408 long, 200 wide with 17 pairs of setae. The lengths of most of these setae follow: L1, 22, L2 22, L3 22, L4 27, L6 31, L7 28, L8 28, L9 47; M2 38; D1 25, D4 18, D5 18. Sternal shield indistinct; genital shield 86 wide; ventrianal shield 144 long, 116 wide with three pairs of preanals and a pair of elliptic pores. Ventrianal shield bordered by four pairs of interscutal setae including VL1 which is 38 long; two pairs of metapodal shields, the primary one 29 long, 9 wide. Fixed digit with four teeth between the *pilus dentilis* and the terminal hook; movable digit with one tooth. Legs without macrosetae.

MALE: Resembles female; dorsal shield 360 long, 200 wide. Ventrianal shield with three pairs of preanal setae and a pair of elliptic pores, Spermatophore bearer with foot 27 long, shank 23 long.

Holotype: Female, San Blas, Nay., March 26, 1957 (D. De Leon), from *Pectis arenaria.* *Paratype:* One male, same data as for holotype.

Typhlodromus (Typhlodromopsis) sabali, n. sp.
(Figures 18-21)

T. sabali resembles *T. reticulatus* Oudemans but differs from Oudemans' description of that species (*in* Nesbit, 1951) chiefly by having a pair of large pores on the ventrianal shield and a macroseta on each of the last three segments of leg IV.

FEMALE: Dorsal shield rather strongly imbricate, 327 long, 195 wide with nine lateral, two median and six dorsal pairs of setae. The lengths of most of these setae follow: L1 24-36, L2 13-19, L3 13-19, L4 22-36, L6 20-33, L9 72-81; M2 46; D1 23, D3 17, D5 20. Sternal shield with three pairs of setae, the posterior pair not set on small posteriorly directed arms; genital shield 73 wide; ventrianal shield 105 long, 95 wide with three pairs of preanal setae and a pair of large pores and bordered by four pairs of interscutal setae including VL1 which is 45 long; two pairs of metapodal shields. Fixed digit with *pilus dentilis* and with eight teeth of rather uniform size and evenly spaced between terminal hook and base of digit; movable digit with three small teeth. Genua I-IV each with a macroseta 18, 18, 26, and 44 long respectively; tibia IV and metatarsus IV each with a macroseta 27 and 48-60 long respectively, the macrosetae of leg IV very slightly enlarged at the tips.

MALE: Resembles female. Dorsal shield 261 long, 185 wide; ventrianal shield with three pairs of preanal setae and a pair of pores. Spermatophore bearer L-shaped, the foot 17 long, the shank 15 long.

Holotype: Male, about six miles northeast of San Blas, Nay., March 28, 1957 (D. De Leon), from *Sabal rosei*. *Paratypes:* Three females, same data as for holotype; three females, two males from *Casearia* spp., other data as for holotype. Other specimens were collected from *Tabebuia*, *Citrus*, and *Rhizophorus* at San Blas.

Typhlodromus (Typhlodromopsis) confertus, n. sp.
(Figures 22-25)

The female of *T. confertus* closely resembles the female of *T. sabali*. The imbrications on the dorsal shield of the former are smaller and more pronounced, the ventrianal shield is a little longer in proportion to its width and it differs in several other apparently minor characters, but the ventrianal shield of the male of *confertus* bears four pairs of preanal setae and the foot of the spermatophore bearer is slightly shorter than the shank, whereas with *sabali* the ventrianal shield of the male bears three pairs of preanal setae and the foot of the spermatophore bearer is slightly longer than the shank.

FEMALE: Dorsal shield 328 long, 205 wide with rather small pronounced imbrications and with nine lateral, two median, and six dorsal pairs of setae. The lengths of most of these setae follow: L1 27, L2 20, L3 19, L4 24-36, L6 22-29, L9 78; M2 47; D1 22, D4 13-17, D5 20. Sternal shield with three pairs of setae; genital shield 76 wide; ventrianal shield 110 long, 94 wide with three pairs of preanal setae and a pair of pores and bordered by four pairs of interscutal setae including VL1 which is 46 long; two pairs of metapodal shields, the primary one 22 long and about 6 wide. Fixed digit with eight teeth proximal of the line of crossing of the movable digit and with a large tooth near base of terminal hook; movable digit with two to three teeth. Legs with rather short stout setae; genua I-IV each with a macroseta 19, 18, 18, and 35 long respectively; tibia IV and metatarsus IV each with a macroseta 12-18 and 50-60 long respectively, the tips very slightly enlarged.

MALE: Resembles female; dorsal shield 267 long, 175 wide; ventrianal shield with four pairs of preanal setae and a pair of pores. Spermatophore bearer L-shaped, the foot about 14 long, the shaft about 17 long.

Holotype: Male, Tuxtla Gutierrez, Ch., January 15, 1957 (D. De Leon), from *Coccolobis* sp. *Paratypes:* Two females, same data as for holotype; two females, A. M. Terrazas, S.L.P., December 21, 1956, from *Hamelia patens;* six females, Veracruz, Ver., December and January from *Verbesina olivacea*, *Heliocarpus tomentosa*, *Eupatorium odoratum*, and *Coccolobis* sp. Additional specimens were collected at Cordoba, Ver., February, from orange; at Tuxtla Gutierrez, Ch., January, from *Eupatorium hemipteropodum* and from many other plants in the above listed places.

Paratypes of the above new species will be deposited in the University of Florida Collections, Gainesville; the holotypes have been retained in the author's collection.

KEY TO SPECIES OF SUBGENUS *TYPHLODROMOPSIS* IN MEXICO

1. Ventrianal shield roughly rectangular with anterior margin convex, constricted at sides and usually widest at a point about in line with base of anus 2

   Ventrianal shield roughly pentagonal or triangular with anterior margin nearly straight, not or scarcely constricted at sides and usually widest at a point about in line with second pair of preanals 5

2. Anterior and posterior preanals crowded toward each other, bases of anterior pair removed from anterior margin of shield 3

   Anterior and posterior preanals normally arranged, bases of anterior pair touching or nearly touching anterior margin of shield 4

3. L1 to L4 about as long as distances between their bases; macrosetae with tips sharp ..... *fiinlandicus* (Oud.)

   L1 to L4 much shorter than distances between their bases; macrosetae with tips strongly expanded ..... *mesembrinus* Dean

4. L8 minute or nearly so, very much shorter than M2 and usually distinctly shorter than L7; genua I-IV each with a macroseta ..... *peregrinus* Muma

   L8 not minute, longer than M2 or L7; genua I-III without macrosetae ..... *planetarius*, n. sp.

5. L2 and L3 as long as or longer than distance to seta behind ..... *quercicolus*, n. sp.

   L2 and L3 shorter than distance to seta behind 6

6. Macrosetae of leg IV strongly expanded at tips; male with spermatophore bearer rather evenly curved ..... *fordycei*, n. sp.

   Macrosetae of leg IV sharp or only slightly expanded at tips 7

7. The pair of pores of ventrianal shield behind and close to bases of third (posterior) pair of preanals ..... *simplicissimus*, n. sp.

   The pair of pores of ventrianal shield between or posteromedial of bases of third pair of preanals 8

8. L1 distinctly shorter than distance to L2; pores of ventrianal shield posteromedial of bases of third pair of setae; male with foot of spermatophore bearer distinctly longer than shank; a large species ..... *cucumeroides*, n. sp.

   L1 about as long as or longer than distance to L2; pores of ventrianal shield in line with or very nearly in line with bases of third pair of preanals; male with foot of spermatophore bearer about as long as shank; smaller species 9

9. Ventrianal shield of male with three pairs of preanal setae ..... *sabali*, n. sp.

   Ventrianal shield of male with four pairs of preanals ..... *confertus*, n. sp.

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THE GENUS *TYPHLODROMUS* IN MEXICO (ACARINA: PHYTOSEIIDAE)

Donald De Leon
Erwin, Tennessee

The genus *Typhlodromus* as here considered comprises only those mites restricted by Chant (1957) to the subgenus *Typhlodromus*. These are typhlodromids with more than four pairs of anterior lateral setae. Four new species are described and collection records are given for seven other species. I can find no record of any member of this group having previously been collected in Mexico. These mites were associated usually with colonies of plant feeding mites on leaves or on twigs of the infested plant. Predatorism was observed but once when a nymph, probably *T. cornus*, was seen to feed on an egg of *Tenuipalpus bakeri* on *Arbutus glandulosa*.

In the descriptions of new species all measurements are in microns and are averages unless the variation from the average is more than ten per cent, in that case the range is given. In this, as in previous papers on the family (De Leon, 1957, 1958), the names suggested by Garman (1948) for distinguishing the setae of the dorsal shield are used.

The females of two species, *T. cornus* and *T. ellipticus*, vary in the number of lateral setae—some specimens have 8, some 9 on a side. The dorsal shield of these two species at S2 on occasion cuts in around this pair of setae on either one or on both sides; the other times it comes down straight on both sides placing the pair on the shield on both sides. In the key to species at the end of this paper these two species consequently are keyed out twice—once under mites with eight lateral setae and once under mites with nine lateral setae.

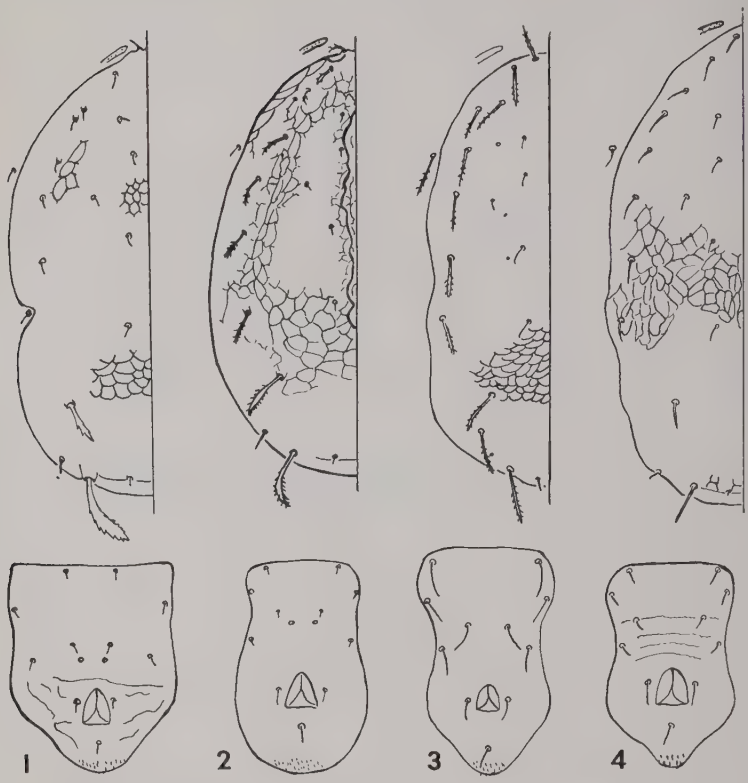
Typhlodromus ellipticus De Leon (1958)

T. ellipticus, known previously only from southern Florida, occurs rather commonly around Veracruz, Ver. In that area it was taken in December 1956 and January 1957 from nine different plants including coconut, *Achras zapota*, and *Ixora*. Other collection records follow: Cordoba, Ver., February 1957, from *Bursera simaruba;* Tuxtla Gutierrez, Chiapas, January 1957, from several hosts; San Cristobal, Chiapas, January 1957, from *Alnus* sp. and Matias Romero, Oax., January 1957, from *Annona* sp.

The pectinations of the dorsal setae are not distinct in some specimens.

Typhlodromus alveolaris De Leon (1957)

This very distinctive mite was described from a single specimen taken on *Cassia* sp. growing on the grounds of the U. S. Plant Introduction Garden near Coral Gables, Fla. In Mexico three specimens were collected March 3, 1957, at Rinconado, Ver., from *Piscidia piscipula*.



All figures are of females. Upper drawing, dorsal shield; lower drawing, ventrianal shield.

Figure 1. *Typhlodromus adjacentis*, n. sp.; Figure 2. *T. carinulatus*, n. sp.; Figure 3. *T. luculentis*, n. sp.; Figure 4. *T. juniperi*, n. sp.

Typhlodromus adjacentis, n. sp.

(Figure 1)

T. adjacentis belongs to the species group with eight lateral setae. It is readily distinguished from the other species in this group by the very short setae of the dorsal shield, the expanded and strongly pectinate margins of M2 and L8, and the nearly pentagonal ventrianal shield.

FEMALE: Dorsal shield reticulate, 304 long, 182 wide with 16 pairs of setae on the dorsal shield as follows: eight laterals, six dorsals, two medians. All setae of dorsal shield short; except for L8 longest lateral seta (L6) is 16 long; L8 50 long, elliptic, somewhat flattened, strongly pectinate; M2 similar to L8, 28 long. Sternal shield indistinct; ventrianal shield 109 long, 84 wide, of shape shown in the figure and with four pairs of preanal setae and a pair of pores; three pairs of interscutal setae, includ-

ing VL1, bordering ventrianal shield; VL1 smooth, 17 long; two pairs of metapodal shields, the primary one in two specimens rather wedge-shaped and two specimens bear what appears to be a faint, small, oval tertiary shield just mediolateral of primary shield. Leg IV with macroseta 18 long.

MALE: Resembles female. Dorsal shield 235 long, 155 wide; ventrianal shield with four pairs of preanal setae and a pair of pores.

Holotype: Female, Aticama, Nay., April 8, 1957 (D. De Leon) from *Randia* sp. *Paratypes:* Two females, same data as for holotype; two females, Tuxtla Gutierrez, Chiapas, January 26 and 27, 1957, from *Telauma mexicana* and *Sapindus saponaria;* one male, Aticama, Nay., April 13, 1957, from coffee.

Typhlodromus cornus De Leon (1957)

One of the most common typhlodromids collected in Mexico was *T. cornus.* Records of representative collections follow: Near San Cristobal, Chiapas, January, from *Trixis* sp., *Persea schideana, Archibaccharis nucrenata* and *Arbutus glandulosa;* Tuxtla Gutierrez, Chiapas, January, from *Sida acuta, Quercus* sp., *Ceiba acuminata,* and other plants; near P. de Vacas, Oax., from *Byrsonima crassifolia;* Huito, Oax., from *Quercus* sp.; Tzintzuntzan and Chuparcuero, Mich., March from *Verbesina* sp., and an unknown host; Guadalajara, Jal., March, from avocado and pomegranate; Tepic, Nay., March, from *Quercus, Pisonia* and other plants.

The Mexican specimens on the whole are larger than Florida specimens and specimens with S2 on the shield (thus giving a count of nine lateral setae) are more common than specimens with S2 in its normal position. Of 53 specimens, 34 per cent have eight pairs of lateral setae, 61 per cent have nine pairs of lateral setae, and 5 per cent have eight lateral setae on one side and nine lateral setae on the opposite side. Specimens with eight or with nine pairs of lateral setae were not restricted to any one place, except possibly Tuxtla Gutierrez where the only specimens collected had eight pairs of lateral setae.

Typhlodromus conspicuus (Garman) (1948)

Records of representative collections of this distinctive species follow: Mante, Tams., December, from *Sapindus saponaria;* Veracruz, Ver., December and January, from Lime, *Pithecolobium, Malvaviscus,* and other plants; Tuxtla Gutierrez, Chiapas and neighboring region, January, from *Trixis* sp., *Zanthoxylum* sp., *Alnus arguta;* Oaxaca, Oax., February, from *Quercus* sp.; Tepic, Nay., March, from *Verbesina* sp., *Baccharis trinerva,* and *Sapium* sp.; San Blas, Nay., March, from *Cedrela* sp., *Ardisia revoluta,* and *Casearia* sp.

Typhlodromus floridanus Muma (1955)

T. floridanus was collected as follows: Veracruz, Ver., January, from *Bumelia* sp.; Tuxtla Gutierrez, Chiapas, January, from *Lippia hypoleia* and from an unknown plant; Tehuantepec, Cax., January, from *Cocos nucifera* and from *Citrus* sp.

Typhlodromus annectens De Leon (1958)

Collection records for this species follow: Mante, Tams., December, from *Croton cortesianus,* Veracruz, Ver., December and January, from *Guazuma tomentosa, Psidium* sp., and cherimoya; San Cristobal, Chiapas, January, from *Alnus arguta;* Tuxtla Gutierrez, Chiapas, January, from *Morus alba* and *Sapindus saponaria;* Acuitzingo, Ver., February, from *Eupatorium petiolare;* San Blas, Nay., May, from *Helicteres guazumaefolia;* Ciudad del Maiz, S.L.P., June, from *Cedrela* sp.

Typhlodromus carinulatus, n. sp.
(Figure 2)

T. carinulatus belongs to the species group with nine lateral setae and M2 unpaired with any other seta. It is readily distinguished from other members of this group in having nearly all the lateral setae pectinate and shorter than the distance to the next seta behind, short smooth dorsal setae, and ventrianal shield with a constriction well towards the anterior end and with a pair of pores.

Female: Dorsal shield 281 long, 172 wide, imbricate-areolate, with a series of more or less coalesced areolae extending down the middle and giving the shield a slightly ridged appearance; seventeen pairs of setae on the dorsal shield, the nine pairs of laterals, except L2, all somewhat to distinctly shorter than distance to seta behind and all pectinate except L8; L1 16, L4 21, L6 23 and L9 37 long; the six pairs of dorsals short, smooth; M1 short, smooth, M2 38 long, expanded, flattened, and strongly pectinate at edges. Sternal shield indistinct; ventrianal shield constricted anteriorly, with four pairs of preanal setae and a pair of pores and bordered by two pairs of interscutal setae including VL1; two pairs of metapodal shields, the primary one lenticular in shape, 21 long, 5 wide. Leg IV without macrosetae.

Holotype: Female, La Tinaja, Ver., February 5, 1957 (D. De Leon), from *Pithecolobium lanceolatum.*

Typhlodromus luculentis, n. sp.
(Figure 3)

T. luculentis belongs to the species group with nine lateral setae, M2 unpaired with any other seta and the ventrianal shield without a pair of pores. The strongly pectinate lateral setae all of about the same length distinguish this species from other members of this group.

Female: Dorsal shield 316 long, 172 wide, strongly imbricate anterior of setae M2 and with 17 pairs of setae as follows: Nine laterals all strongly pectinate, six dorsals only D1 pectinate, and two medians. The lengths of most of these setae follow: L1 31, L2 31, L3 29, L4 33, L5 36, L6 35, L7 36, L8 34, L9 39; D1 31, D5 18; M1 18, M2 39; VL1 34 (faintly pectinate). Sternal shield with two pairs of setae; ventrianal shield with four pairs of preanals, no pores, and bordered by three pairs of interscutal setae including VL1; two pairs of metapodal shields, the primary one oval, 19 long, 5 wide. Leg IV without macroseta.

MALE: Resembles female. Dorsal shield 255 long, 159 wide; ventrianal shield with four pairs of preanal setae and no pores.

Holotype: Female, Tuxtla Gutierrez, Chiapas, January 11, 1957 (D. De Leon), from *Guazuma tomentosa*. *Paratypes:* One male, same data as for holotype; one male, January 15, 1957, from *Cecropia peltata*, other data as for holotype.

Typhlodromus pacificus McGregor (1956)

T. pacificus was collected in the following localities: Reynosa, Tams., December, from *Croton torreyana* and *Melochia tomentosa;* P. de Vacas, Oax., January, from *Byrsonima crassifolia;* Arenal, Jal., March, from *Lagascea* sp.; Encinal, S.L.P., June, from *Quercus* sp.

Typhlodromus juniperi, n. sp.

(Figure 4)

T. juniperi belongs to the species group with nine pairs of lateral setae, M2 unpaired with any other seta and the ventrianal shield without a pair of pores. It differs from other members of this group by having L2 and L3 short and M2 reaching less than halfway to L9.

FEMALE: Dorsal shield reticulate 334 long, 181 wide with seventeen pairs of setae of the following lengths: L1 16-20, L2 13-20, L3 15-18, L4 13-20, L5 19, L6 18-24, L7 20, L8 11-18, L9 30; D1 17, D2 12, D3 11, D4 11-15, D5 11-18, D6 10; M1 11-15, M2 20; VL1 22. Sternal shield with two pairs of setae; ventrianal shield 98 long, 58 wide with four pairs of preanal setae and no pores and bordered by two pairs (one specimen has three pairs) of interscutal setae including VL1; two pairs of metapodal shields, the primary one 24 to 39 long and about 6 wide, the secondary one narrowly oval and about 10 long. Leg IV with a slender macroseta.

MALE: Resembles female. Dorsal shield 259 long, 165 wide; ventrianal shield with four pairs of preanals and no pores. Foot and shank of spermatophore bearer about equal in length and at about right angles to each other.

Holotype: Female, Reynosa, Tams., December 18, 1956 (D. De Leon), from *Croton torreyana*. *Paratypes:* One male, two females, Huito, Oax., February 1, 1957, from *Juniperus* sp.; one female, Carmen, Puebla, March 4, 1957, from *Juniperus* sp.

Paratypes of the above new species will be deposited in the University of Florida Collections, Gainesville.

KEY TO SPECIES (FEMALES) WITH MORE THAN FOUR PAIRS OF ANTERIOR LATERAL SETAE

1. Dorsal shield with 8 pairs of lateral setae 2
   Dorsal shield with 9 pairs of lateral setae 6

2. Most lateral setae coarse, narrow-elliptic, or pectinate or a combination of these characters 3
   Most lateral setae slender, simple, and tapering gradually to a point 4

3. Anterolateral area of dorsal shield alveolate, lateral setae very coarse ..... *alveolaris* DeL.

   Anterolateral area of dorsal shield imbricate, or rather smooth; lateral setae narrow-elliptic and usually distinctly pectinate ..... *ellipticus* DeL.

4. Bases of L2 and L3 about their own diameter apart; L1 to L5 (except L2) reaching less than halfway to seta behind .... *adjacentis*, n. sp.

   Bases of L2 and L3 well separated from each other; L1 to L5 reaching more than halfway to base of seta behind 5

5. L7 over one-half as long as L8; leg IV without macrosetae; body brownish ..... *conspicuus* (Garman)

   L7 less than half as long as L8; leg IV with macroseta; body light tan or whitish ..... *cornus* DeL.

6. D2 to D5 very long, reaching to, or well beyond base of seta behind; leg IV without macroseta 7

   D2 to D5 short, reaching about to or falling well short of seta behind; leg IV with or without macroseta 8

7. Peritreme reaching forward to beyond middle of coxa I; most setae of dorsal shield smooth; male with triangular scoop-shaped apophysis on femur II; larger species, female with dorsal shield 340-400 long ..... *floridanus* Muma

   Peritreme not reaching forward to beyond middle of coxa I, usually only as far as middle of coxa II; most setae of dorsal shield pectinate; male without apophysis on femur II; smaller species, female with dorsal shield 240-290 long ..... *annectens* DeL.

8. Ventrianal shield with a pair of pores 9

   Ventrianal shield without pores 11

9. Most lateral setae smooth, simple, and tapering gradually to a point; ventrianal shield distinctly "waist-shaped" ..... *cornus* DeL.

   Most lateral setae pectinate, narrow-elliptic, or narrow elliptic and pectinate; ventrianal shield scarcely "waist-shaped" or not at all.. 10

10. Bases of L2 and L3 close together; D2 to D5 tapering, slender, simple ..... *carinulatus*, n. sp.

    Bases of L2 and L3 well removed from each other; D2 to D5 narrow-elliptic and usually pectinate ..... *ellipticus* DeL.

11. Most lateral setae pectinate ..... *luculentis*, n. sp.

    Only seta L9 of lateral series may be pectinate 12

12. M2 reaching much more than halfway to base of L9; L4, L5, and L6 reaching to or nearly to base of seta behind ..... *pacificus* McG.

    M2 reaching distinctly less than halfway to base of L9; L4, L5, and L6 reaching about halfway or less to base of seta behind *juniperi, n. sp.*

ACKNOWLEDGMENTS

I wish to thank Dr. Rogers McVaugh of the University of Michigan for identifying plants collected in Jalisco, Nayarit, and Michoacan; Mr. Miguel Angel Palacios Rincón of the Instituto de Historia Natural de Chiapas for identifying plants collected in the vicinity of Tuxtla Gutierrez; and Dr. Faustino Miranda of the Instituto de Biologia, Mexico, D. F., for identifying plants collected in the other states.

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A UNIQUE NEW NORTH AMERICAN SPECIES OF PINE-CONE-FEEDING *LASPEYRESIA* RELATED TO *L. INGENS* HEINRICH (LEPIDOPTERA, OLETHREUTIDAE)

WILLIAM E. MILLER[1]
Lake States Forest Experiment Station
Forest Service, U. S. Department of Agriculture

In their investigations of pine cone and seed insects, U. S. Forest Service entomologists at the Southeastern Forest Experiment Station have reared a species of *Laspeyresia* which is undescribed. The orange-like coloration of the moth distinguishes this species immediately from all other known members of the genus; no other described species of *Laspeyresia* approaches such a hue. *Laspeyresia ingens*, which is a superficially gray moth, appears to be the nearest relative. The new species is described below and given the specific name *anaranjada*, the Spanish adjective meaning orange.

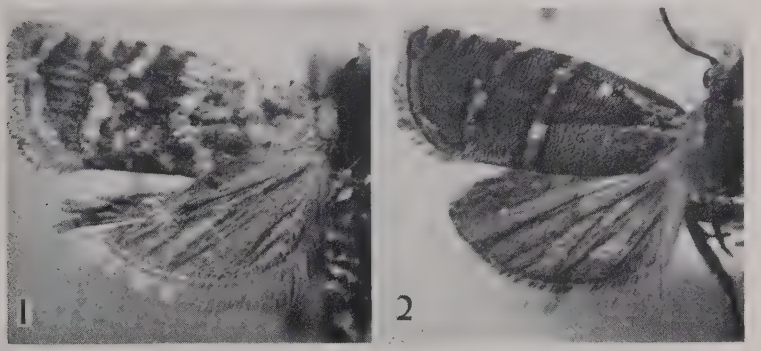

Figure 1. Adult of *Laspeyresia anaranjada* from Sarasota Co., Florida.
Figure 2. Adult of *L. ingens* from Dare Co., North Carolina.

Laspeyresia anaranjada, new species

Wingspan 16.0 mm.

Labial palpus, head, and collar beige; antenna slightly lighter beige. Patagium and upper side of thorax beige, faintly tinged with rust. Underside of thorax pearl-white.

Forewing light rust with four more or less equally spaced, mostly pearl-white crossbands, the apical one being situated just inside termen. Between the apical and the next crossband are two partial crossbands which extend back from the leading edge of the wing 1/7 of its width in that area. The second crossband inward from the apex has a slight break just costad of the middle of the wing. Lead-colored scales comprise the apical edges of much of the second crossband and a little of the third. Two more partial

[1] Stationed at the East Lansing, Michigan, field unit. The field unit is maintained in cooperation with Michigan State University.

crossbands originate on trailing edge between the two middle crossbands and extend forward ⅛ the width of the wing in that area. The innermost crossband not as distinct as the other three. Cilia of fore- and hindwings pearl, tinged with brown.

Hindwing covered with rust-tipped beige scales. Undersides of wings beige, slightly darker in the forewing than in the hindwing.

Legs pearl-white except for outer sides of tarsal segments which are beige with white apical bands. Abdomen pearl-white.

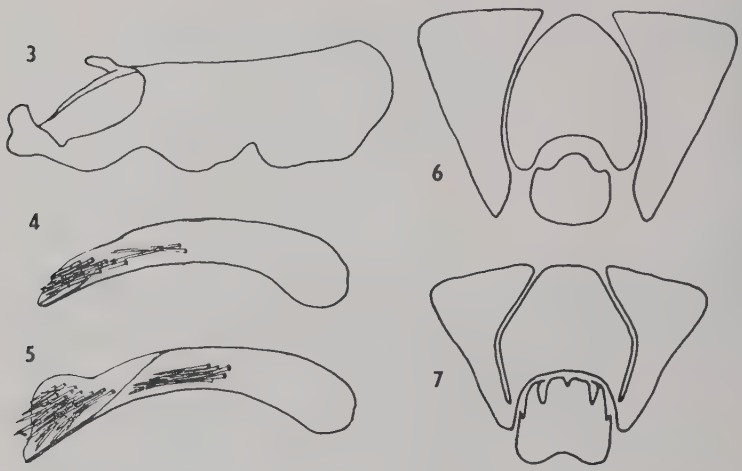

Figure 3. Valva of *Laspeyresia anaranjada.*
Figure 4. Aedeagus of *L. anaranjada.*
Figure 5. Aedeagus of *L. ingens.*
Figure 6. Genital plate of *L. anaranjada.*
Figure 7. Genital plate of *L. ingens.*

Variations from the above description of the holotype female were found among the four paratypes as follows: The labial palpus, head, antenna, and collar may be much lighter in color, approaching pure white. The second crossband inward from the wingtip may be broken more than once and hence consist of several segments (Figure 1). Also, the forewing may have a half dozen or so small patches of silvery white scales of the same kind as comprise the crossbands. Finally, tarsal segments may be brown with white bands rather than beige with white bands.

The species is described from the female type (U. S. National Museum Catalog Number 64675) which has label data as follows: "Cordele, Ga. 5/21/50, *Pinus palustris* cones, C. F. Speers Collector, ♀ genitalia slide 2.VI.58 W. E. Miller." The town of Cordele is in Crisp County.

Four specimens with label data as follows are designated paratypes: (1) "Cordele, Ga. 5/22/50, C. F. Speers Collector, *Pinus palustris* cones, ♂ genitalia on slide 19.IX.1950 J.F.G.C. 9737"; (2) same label data except 5/20/50; (3) same label data except 5/17/50; and (4) "Archbold Biol. Sta.

Highlands Co., Fla., VI:12-19:55; at light, Coll. by A. K. Wyatt, 14056, ♂ genitalia slide 6.XI.58 W. E. Miller."

Also seen were seven other specimens from Cordele, Georgia, and Siesta Key (Sarasota County), Florida. All material is in the U. S. National Museum. A better characterization of the species would probably have resulted from the same number of specimens in better condition than the available ones.

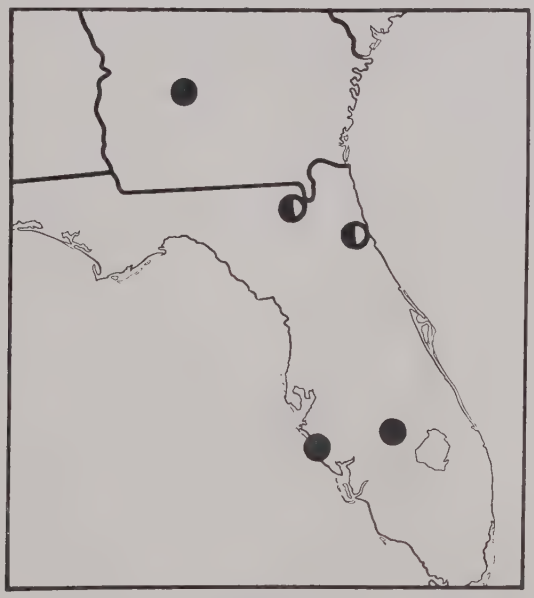

Figure 8. Known distribution of *Laspeyresia anaranjada*. Solid points are records based on specimens seen; other points are records based on specimens in the collection of the Southeastern Forest Experiment Station (E. P. Merkel, in correrpondence).

The wingspans of 2 *Laspeyresia anaranjada* males were 14.0 and 15.0 mm., and those of 7 females averaged 15.9, ranging from 15.0 to 17.0 mm.

Genitalia of three males from Siesta Key, Cordele, and Archbold Biological Station and of three females from Cordele and Siesta Key were studied. The male valva and aedeagus are shown in Figures 3 and 4 and the female genital plate in Figure 6. These structures appeared to be the genitalic ones with the greatest diagnostic value.

Laspeyresia anaranjada differs in many ways from *L. ingens* (Figure 2), but the most striking is coloration. Another difference lies in the shape of the valvae. The middle lobelike process seen in the valva of *L. anaranjada* may be either completely lacking or much reduced in *L. ingens*. There are different numbers of cornuti, ranging from 3 to 4 in *L. anaranjada*

compared with 8 to 11 in *L. ingens* (Figure 5); different numbers of apical spines on the aedeagus, there being 12 to 14 in *L. anaranjada* compared with about 30 in *L. ingens;* and a difference in the shape of the genital plate (Figures 6 and 7) (genitalia of one *L. ingens* female (paratype) seen from St. Petersburg, Pinellas County, Florida, and four *L. ingens* males from Kill Devil Hills, Dare County, North Carolina, and St. Petersburg, Florida). Female genitalia of *L. ingens* have been illustrated by Heinrich.[2]

Laspeyresia anaranjada moths have emerged from about mid-March till mid-May, and they have been reared from larvae infesting mature cones of slash pine, *Pinus elliottii* var. *elliottii* Engelmann (E. P. Merkel, in correspondence) and longleaf pine, *Pinus palustris* Miller.

The known geographic distribution of *Laspeyresia anaranjada* is southern Georgia and Florida (Figure 8). It probably has a wider distribution, however, since the hosts which it is known to attack occur over a much larger area.

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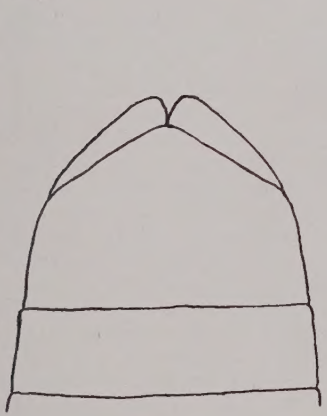
[2] *Heinrich, C.* 1926. Revision of the North American moths of the subfamilies Laspeyresiinae and Olethreutinae. U. S. Nat. Mus. Bul. 132: 1-216.

NARCEUS WOODRUFFI, NEW SPECIES, A FLORIDA MILLIPED (SPIROBOLIDA: SPIROBOLIDAE)

NELL B. CAUSEY
Fayetteville, Arkansas

Florida, with representatives of three genera of spirobolid millipeds, is the most important center of speciation of this order east of the Rocky Mountains (Causey, 1955). There are no records from more than half of the counties, but with careful collecting, all should yield one or more species. In Alachua County, for example, four species have been collected.

The most restricted spirobolid genus in Florida is the monotypic *Floridobolus* (Causey, 1957; Keeton, 1959), which is known from only one locality in Highlands County. Four forms of the genus *Chicobolus* occur from Key West north into the panhandle and on through Georgia and into South Carolina. The complex genus *Narceus* occurs from Key West north into the New England States and west as far as 97° longitude; in Florida, where it has attained its greatest diversity, some forms have overlapping ranges.



Narceus woodruffi, new species, male holotype. Fig. 1. Last two body segments, dorsal view. Fig. 2. First two segments of the right legs of the third, fourth, and fifth pairs, cephalic view.

The male gonopods are so uniform throughout the genus *Narceus* they are of little value for making specific determinations. The taxonomy is based chiefly upon the shape of the coxal lobes of the legs anterior to the gonopods; also the following somatic characters have varying and unequal value: size, ratio of body thickness to length, color, shape of the collum, height of the mesial margin of the anal valves, and the size and distribution of the microscopic puncta on the exoskeleton.

Narceus woodruffi is the smallest, darkest, and has the most restricted range of any species of the genus. It is named for Mr. Robert E. Woodruff, who collected the holotype.

Narceus woodruffi, n. sp.

Figures 1 and 2

DIAGNOSIS: Distinguished from all other species of the genus by the rectangular, elongated, and subequal coxal lobes of legpairs 3, 4, and 5 of the male, and by the dark black-brown color, the small and relatively thin body, and the low mesial margins of the anal valves.

TYPE LOCALITY: 4.2 miles south of Hawthorn, Putnam County, Florida. "The habitat," wrote Mr. Woodruff, "is known locally as high pine-turkey oak and contains an unusual association of plants and animals. The milliped was dug from beneath a pile of cow dung."

RANGE: Known only from Putnam and Alachua Counties, Florida.

DEPOSITION OF TYPE MATERIAL: Male holotype, American Museum of Natural History; female paratypes, Florida State Plant Board, Gainesville, Florida, and the author's collection.

DESCRIPTION OF MALE HOLOTYPE: Greatest body width 4 mm., length about 50 mm., 49 segments, the last one legless. Body color in alcohol black-brown, the hindbelts slightly darker than the midbelts on some segments, legs and antennae dark red. Body surface shining, coarsely punctate, the puncta most numerous in and on each side of the segmental furrows. Setigerous labral foveolae 4 + 5. Ocelli black, flat, closely arranged in five series in a subtriangular area. Mandibular cheek with the usual shallow antennal furrow, which is not at all covered by the collum; anterioventral margin of mandibular cheek with the usual small, acute lobe. Antennae long enough to reach back about halfway between the anterior and the posterior margins of the collum. Anterior margin of collum very slightly concave at the level of the mandibular cheek and with the usual narrow margin. Lateral lobes of second segment extend well below the collum and are acutely triangular. Segmental furrows continue faintly across the dorsum of all except the last three or four segments, where they are absent. Caudal tergite triangular, the apex thin and flat and narrowly rounded; ratio of length of caudal tergite to length of anal valves, as viewed from above, about 5/1. Mesial margin of anal valves (Figure 1) not raised. Anal scale with both margins rounded, the ratio of the width to the length about 4.5/1.

Coxal lobes of legpairs 3, 4, and 5 are similarly and conspicuously elongated and different from any others in the genus in that all three pairs are broad, subrectangular, and flattened (Figure 2); the coxal lobes of legpair 5 are a little shorter, broader, thinner, and the mesial angle is a little less rounded than the others. The ratio of the length of the coxal lobes of legpairs 3, 4, and 5 to the length of the second segments of those legs is, respectively 5/3, 5/3, and 4/3. Coxae of legpairs 6 and 7 are not elongated.

Anterior gonopods with the medio-ventral projection of the sternum rounded at the apex, about as long as broad, and relatively small; coxal endite lobes broadly and evenly rounded along the ventral margin. Pos-

terior gonopods with the apex of the distal joint rectangular as in *Narceus keysi* Loomis.

FEMALE PARATYPES: Somatic characters are almost as in the male, except that the body surface is duller, the puncta on the body surface are more scattered, and there is a horizontal depression across the anal tergite. One female specimen, apparently mature, has a body width of 4.7 mm. and 46 segments, the last one legless. The other female, which lacks at least one molt of maturity, has a body width of 3.5 mm. and 49 body segments, the last one legless.

RECORDS: *Florida:* Alachua Co.: Exact site unknown, 2 ♀, June 16-19, 1949, collected by "Oliver" at "Trap 4", collection of the Florida State Plant Board. Putnam Co.: Hawthorn, 1 ♂, Jan. 17, 1959, R. E. Woodruff, collection of the Florida State Plant Board.

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Book Review

MITES, OR THE ACARI, by T. E. Hughes. vii + 225 pp. Athlone Press, London (distr. by Essential Books, Fair Lawn, N. J.). 1959. Price $6.75.

Either directly or indirectly American Acarologists, like the Entomologists before them, give the impression that the need for purely descriptive and economic work makes studies of comparative zoology a luxury we can do without. But in the last 75 years a great deal of very important information on life histories, behavior, structure, and physiology of mites has been accumulated, especially in Europe. H. Graf Vitzthum reviewed some of the literature but a small war-time printing made his volume an exhorbitantly priced rarety. With the publication of *Mites, or the Acari* we have a survey of this literature that is abundantly illustrated with freshly executed drawings. (Both the legends and the labels of the plates are very poorly planned and difficult to use.)

The early chapters discuss life cycles, behavior, and feeding habits and are followed by a detailed survey of anatomy (both internal and external) and development. Happily, function is discussed in these sections and anatomy is shown to involve more than a superficial survey of exoskeletal geography.

Hughes' terse, factual treatment is so arranged as to enable one to easily search out information as it is needed and the sources are generally cited. Much of the data on mite biology and structure is so widely scattered and unorganized that assembling information is a formidable task. A book of these modest proportions could not cover the field in great detail and probably many specialists will find lapses and omissions that appear serious (e.g. hardly any of the excellent works on water-mite biology and structure are mentioned and what is given is deficient). Any sins of omission are outweighed by the demonstration of the kind of information that will lead to an understanding of mites as functioning organisms. Not only is this understanding important in itself but it will give depth to one's understanding of systematics through a genuine appreciation of adaptations and the evolution producing them.

The perceptive biologist will find much in this volume that is interesting and worthy of thought. Entomologists and Acarologists will find it a useful reference and, perhaps, a refreshing stimulus to further work on the comparative zoology of mites.—*Rodger Mitchell.*